

# **Application of different VHR satellite images for detailed mapping of forest spatial structure properties in the forest-tundra ecotone**

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# Tasks:

- To create a method for automated single trees extraction from VHR satellite imagery
- To estimate applicability of “enhanced shadow-vegetation method” for VHR processing
- To create maps of spatial structure characteristics for study areas
- To create medium-scale materials for regional scale studies using coarser imagery

# Trees as object for extraction

- Properties

- Position
- Height of a tree
- Crown coverage
- Stem density

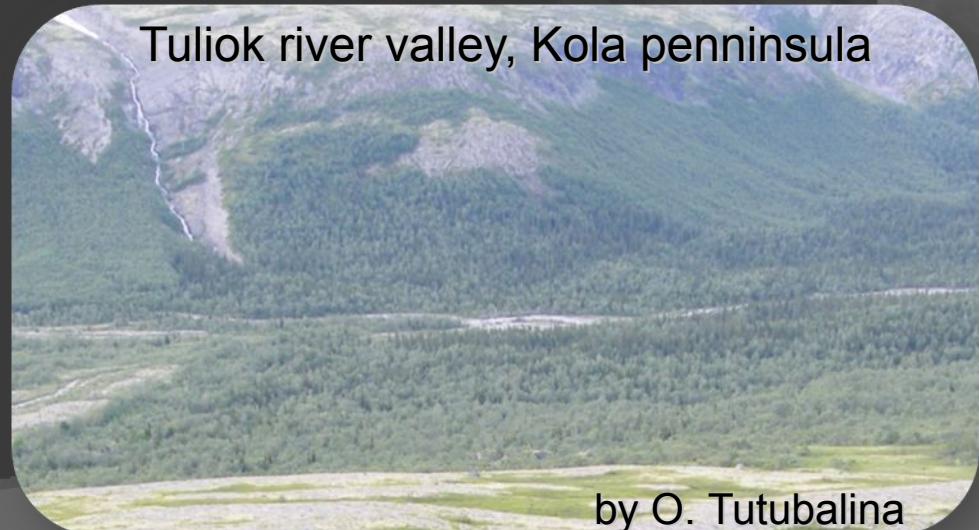
Delineated species:

Birch - *Betula pubescens*, *B. tortuosa*

Spruce - *Picea obovata*, *Picea lapponica*

Larsh - *Larix gmelinii*,  
*Larix sibirica*

Tuliok river valley, Kola peninsula

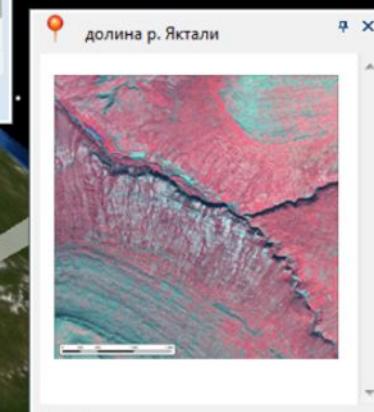
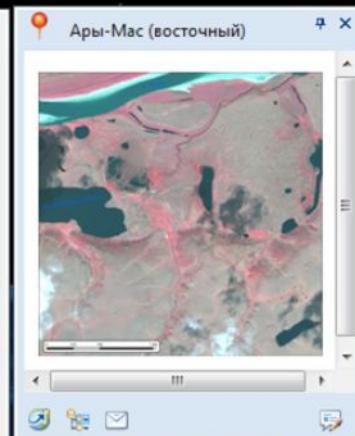
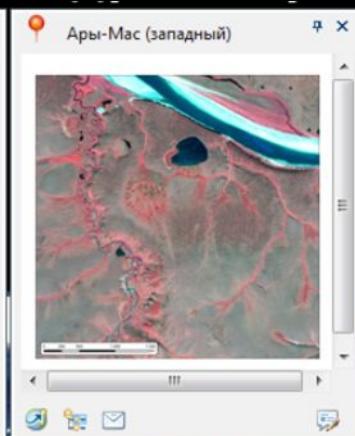
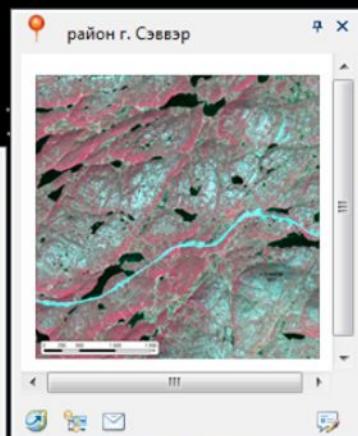


by O. Tutubalina

# Study sites:

Kannentiavr lake region,  
Kola peninsula

2 sites in Ary-Mas region,  
Southern Taimyr

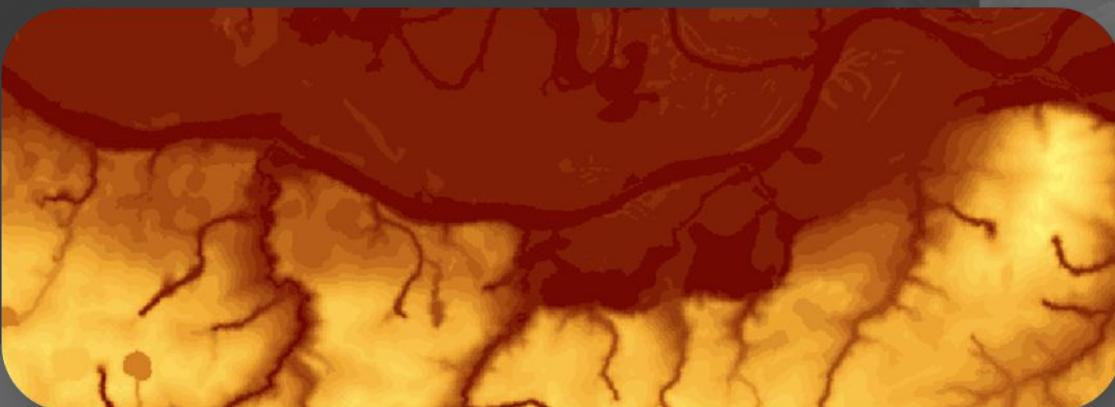


Tul'ok river valley,  
Khibiny Mountains

Yaktali river valley,  
Putorana Plateau

# Geodata used:

- Satellite imagery ( $<1m/pixel$ )
  - IKONOS (0,8 m)
  - QuickBird (0,6 m)
  - GeoEye (0,5 m)
  
- DEMs
  - Created using topo-maps
    - 25, 50 m resolution
  - ASTER GDEM
    - 30m resolution
  - GeoEye Stereo
    - 3 m resolution



# Methods

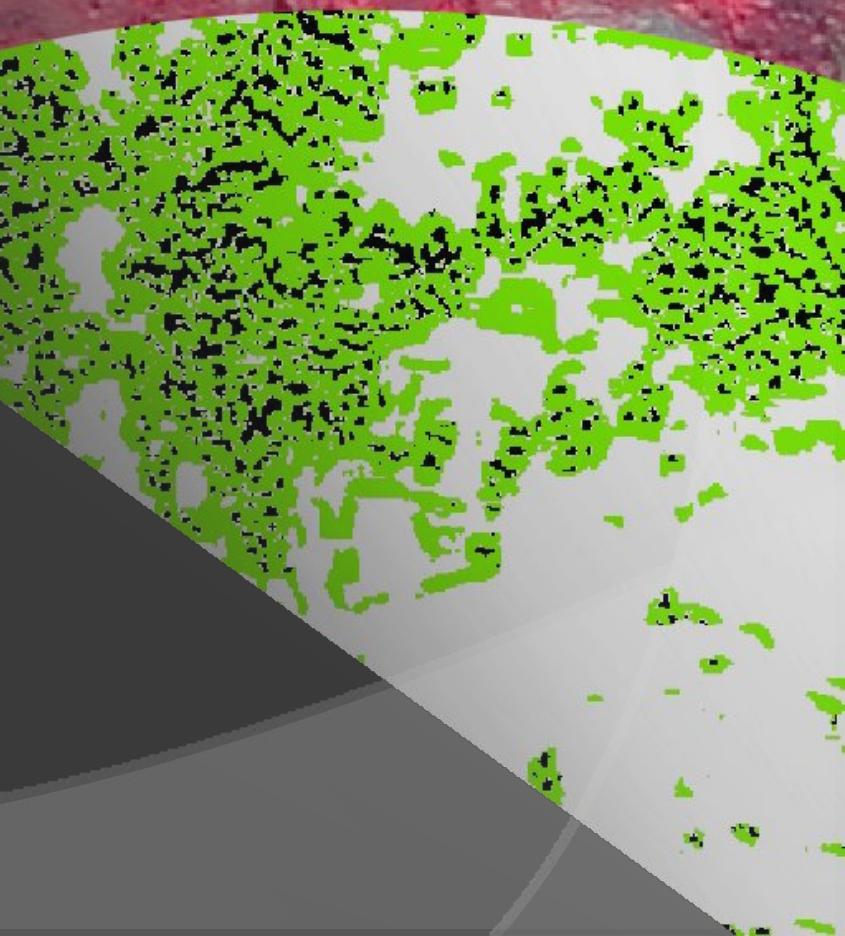
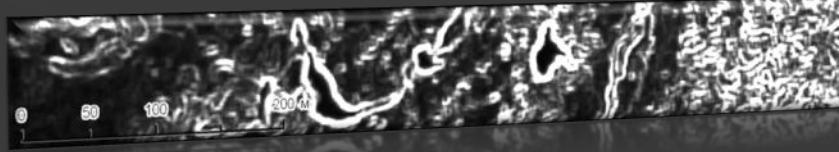
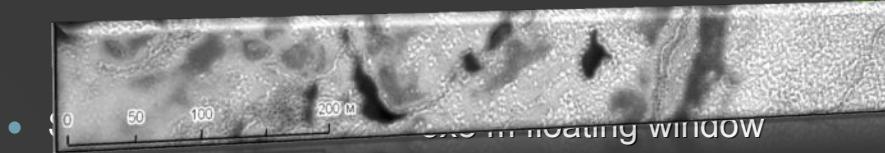


# Step1: Classification

- Classification of VHR satellite image to 3 classes: Vegetation/Shadows/Other using MS image and some products:

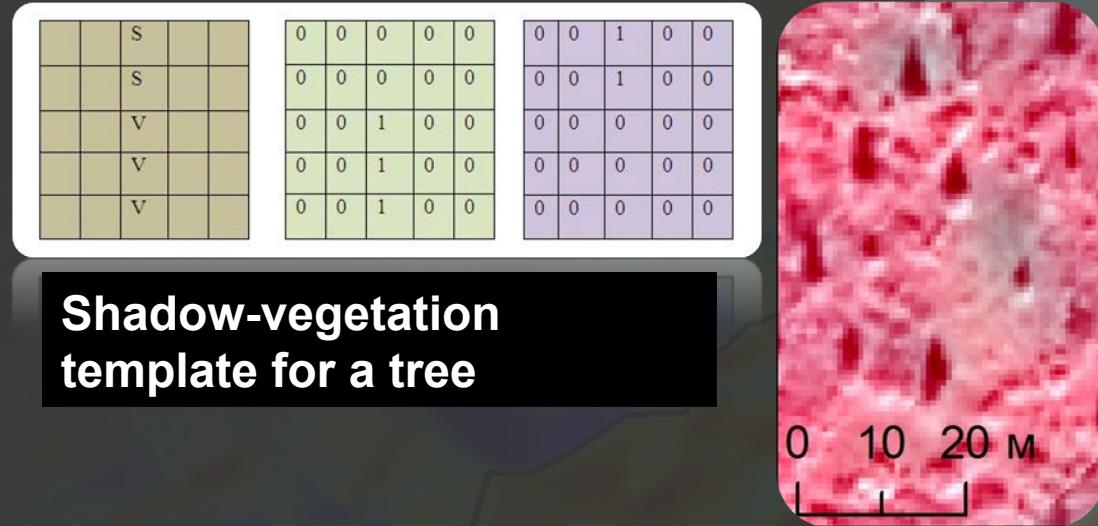
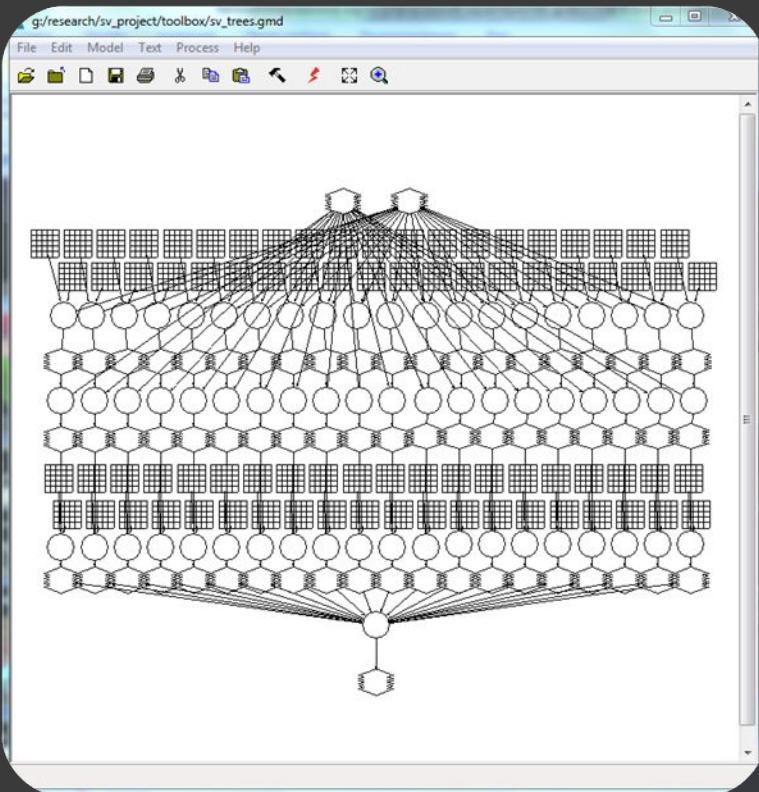


- NDVI



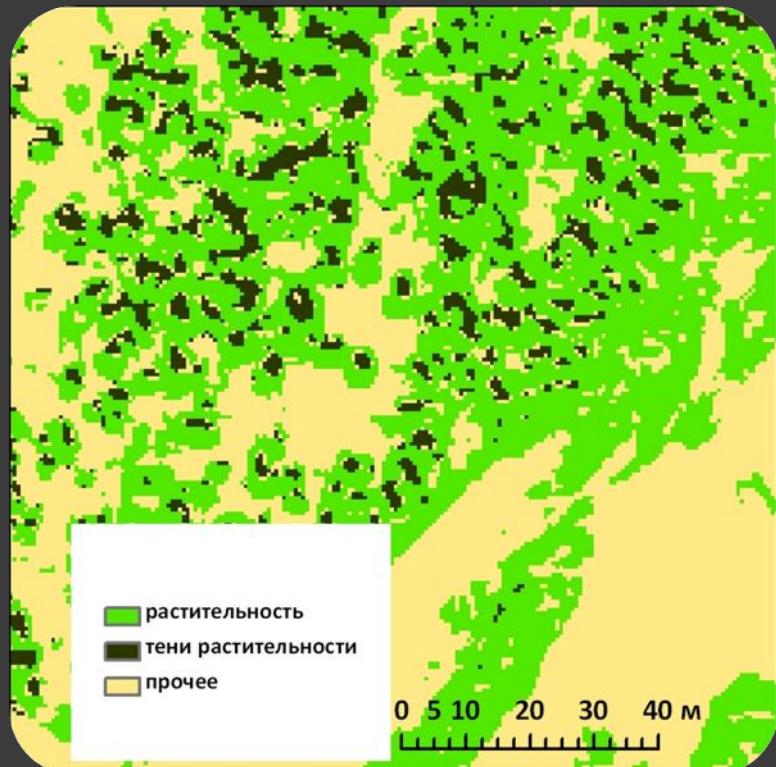
# Step 2: Trees extraction

- Feature extraction performed on classified image

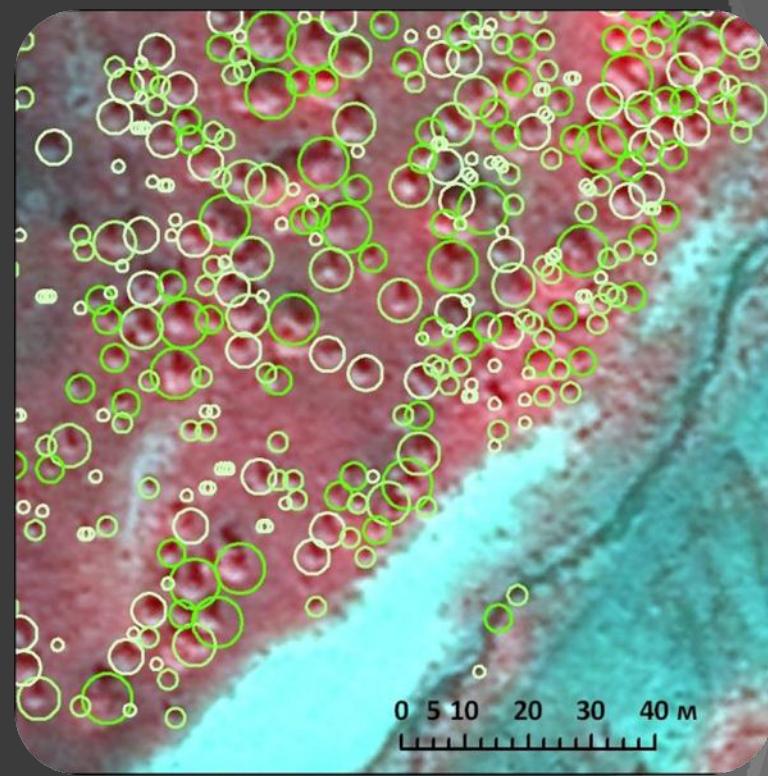


- Focal analysis fitted to different shadow lengths
- Exclusion of multiple selection of trees

# Results of 1<sup>st</sup> and 2<sup>nd</sup> steps:



Classified image

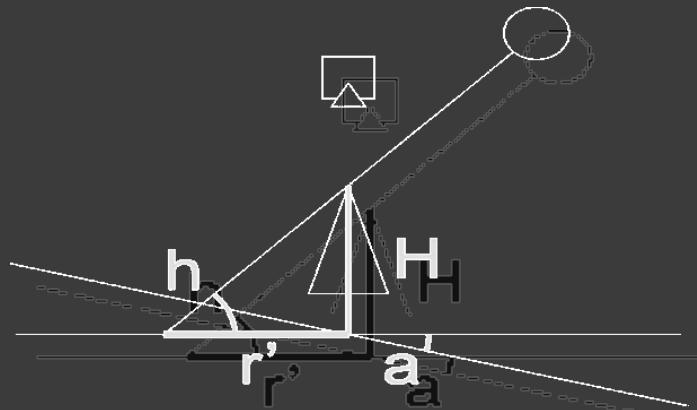


Selected trees  
(already a vector dataset)

# Step 3: Height of trees calculation

$$H = L' * [\tan(slope * \cos(a_s - aspect)) + \tan h_s]$$

- $L'$  – shadow length on the image
- slope – slope on DEM
- aspect – aspect on DEM
- $A_s$  – Azimuth of Sun
- $h_s$  – Height of Sun above horizon



Shadow to height coefficient distribution

# Accuracy assessment:

Site	Spatial resolution , m (sensor)	Commission error, %	Omission error, %
Tuliok river	0,5 (GeoEye)	17*	17*
Kannentiavr lake	0,6 (QuickBird)	26*	8*
Ary-Mas (west)	0,8 (Ikonos)	15*	43*
Ary-Mas (east)	0,6 (QuickBird)	23*	12*
Putorana Plato	0,6 (QuickBird)	16*	8*

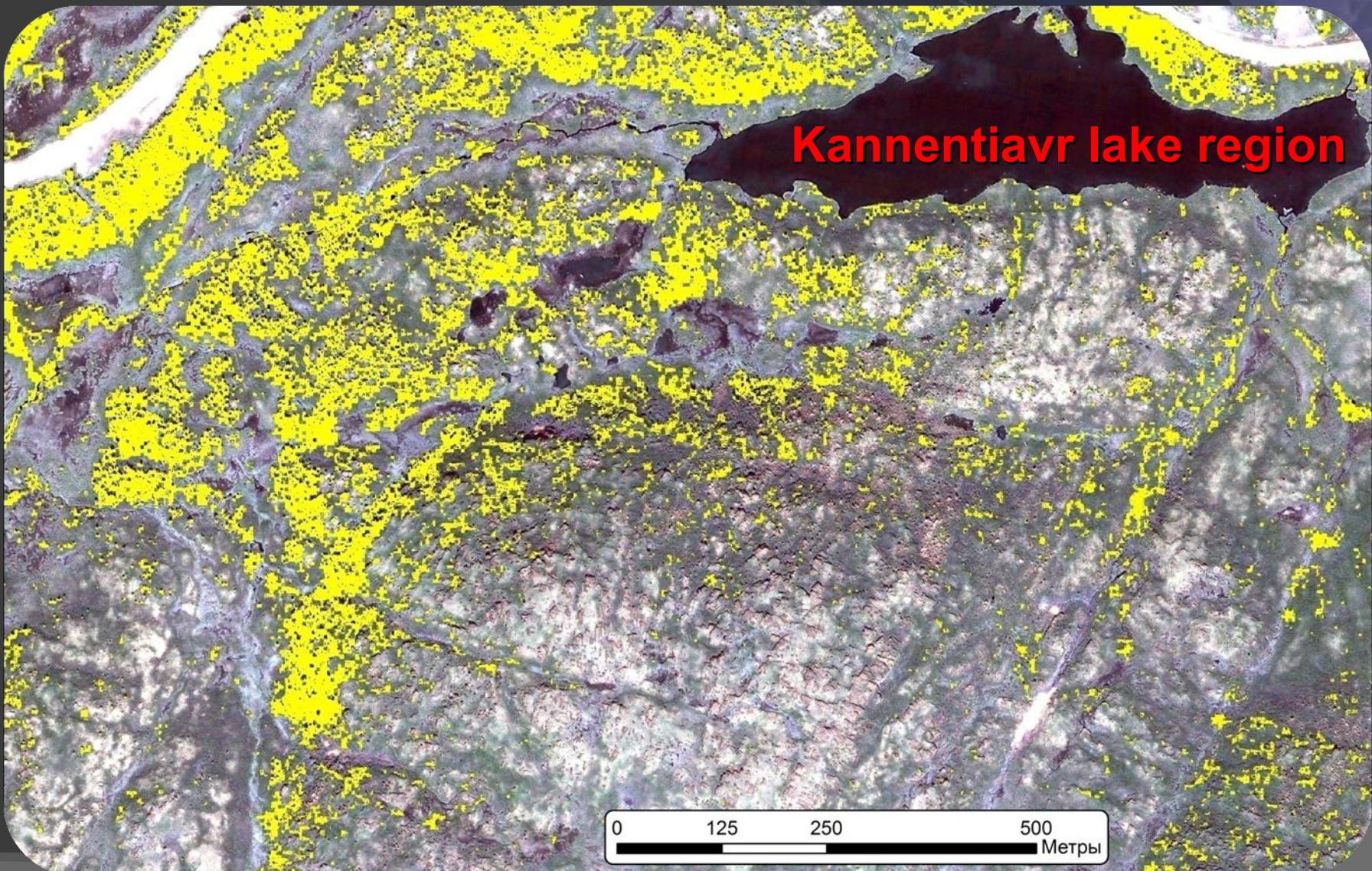
Assessment bases on 16000 visually interpreted trees (about 3200 trees/site)

\* For sparse forest commission/omission errors are less than 10%

# Products



# Projection of crones

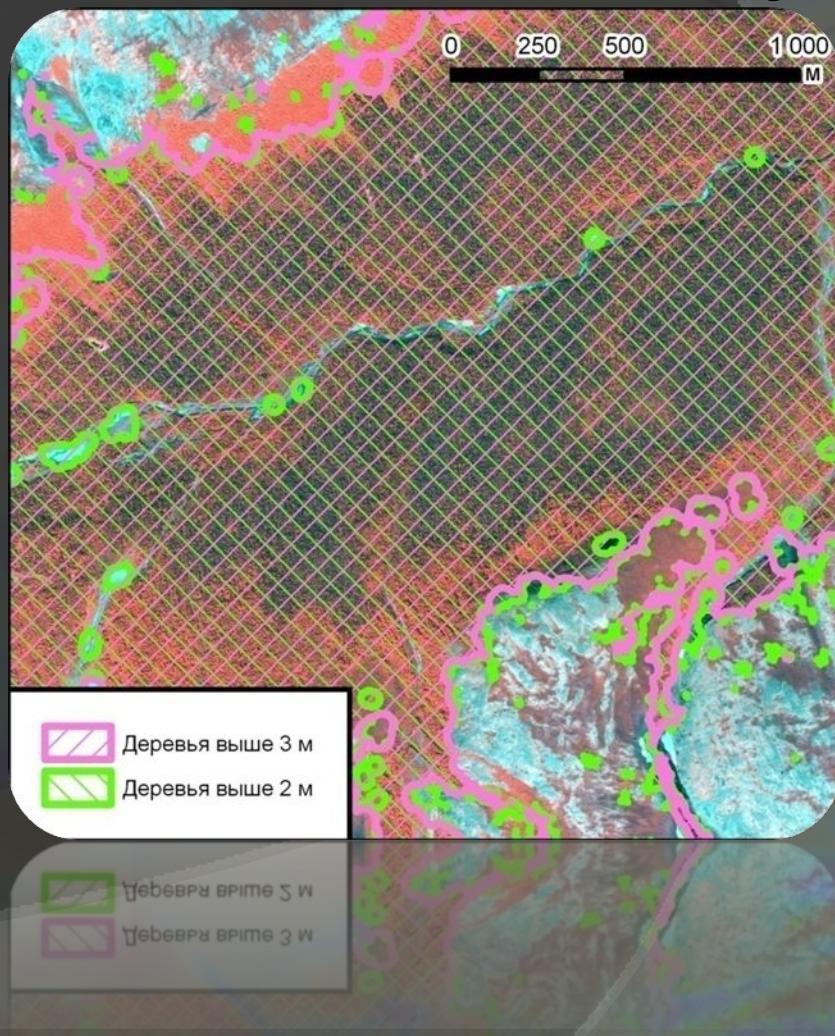
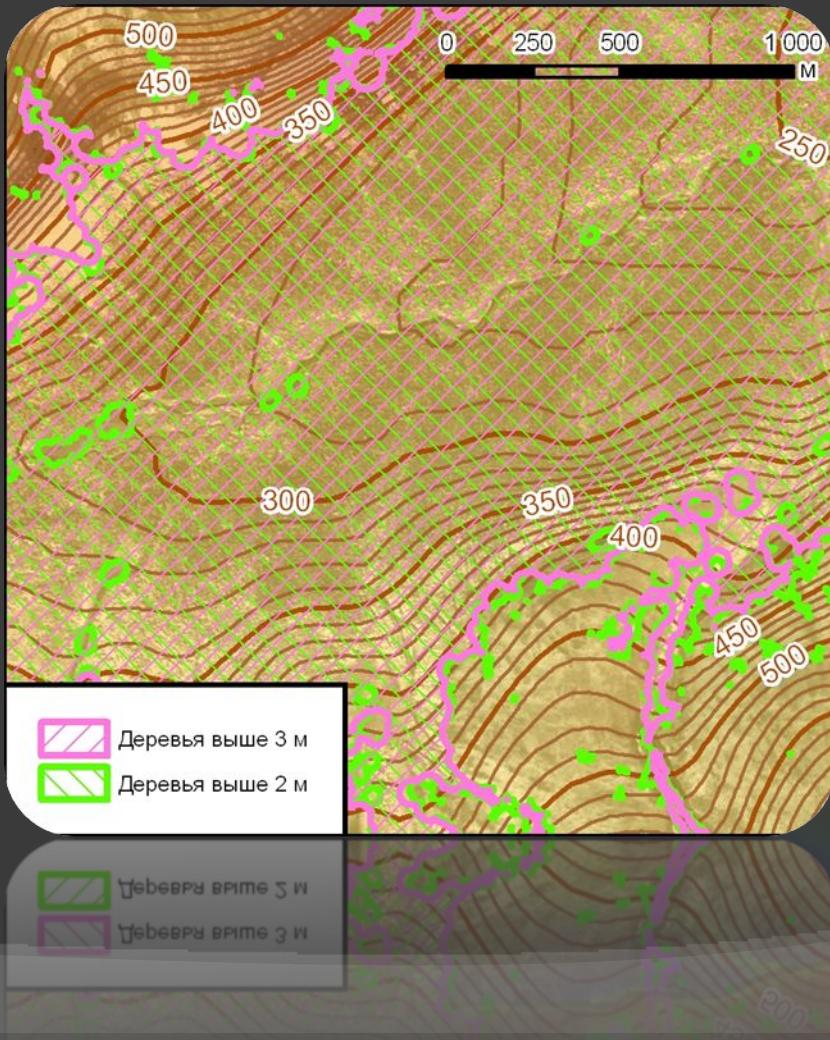


# Distribution of trees



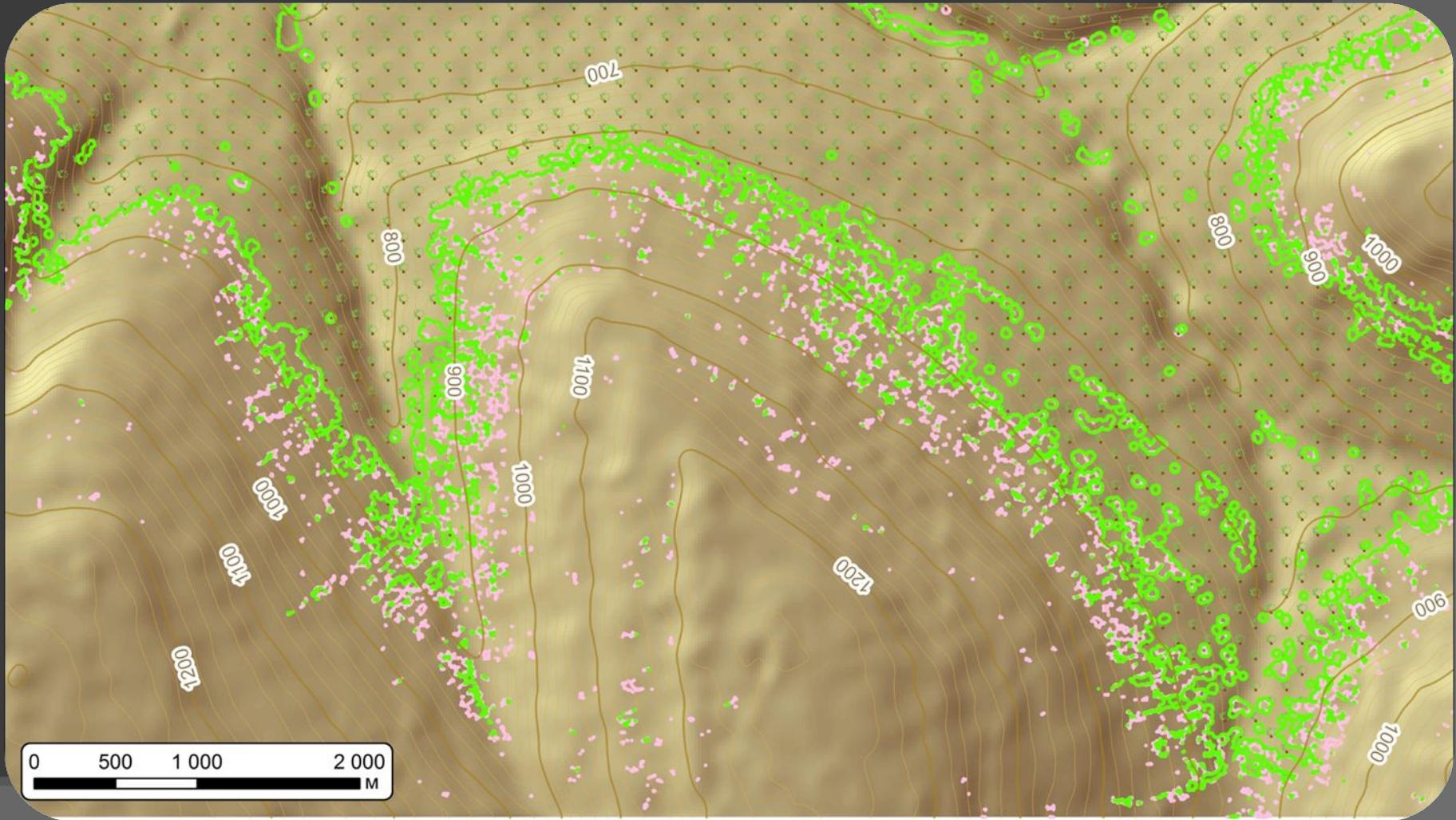
# Forest line and tree line

Tuliok river valley



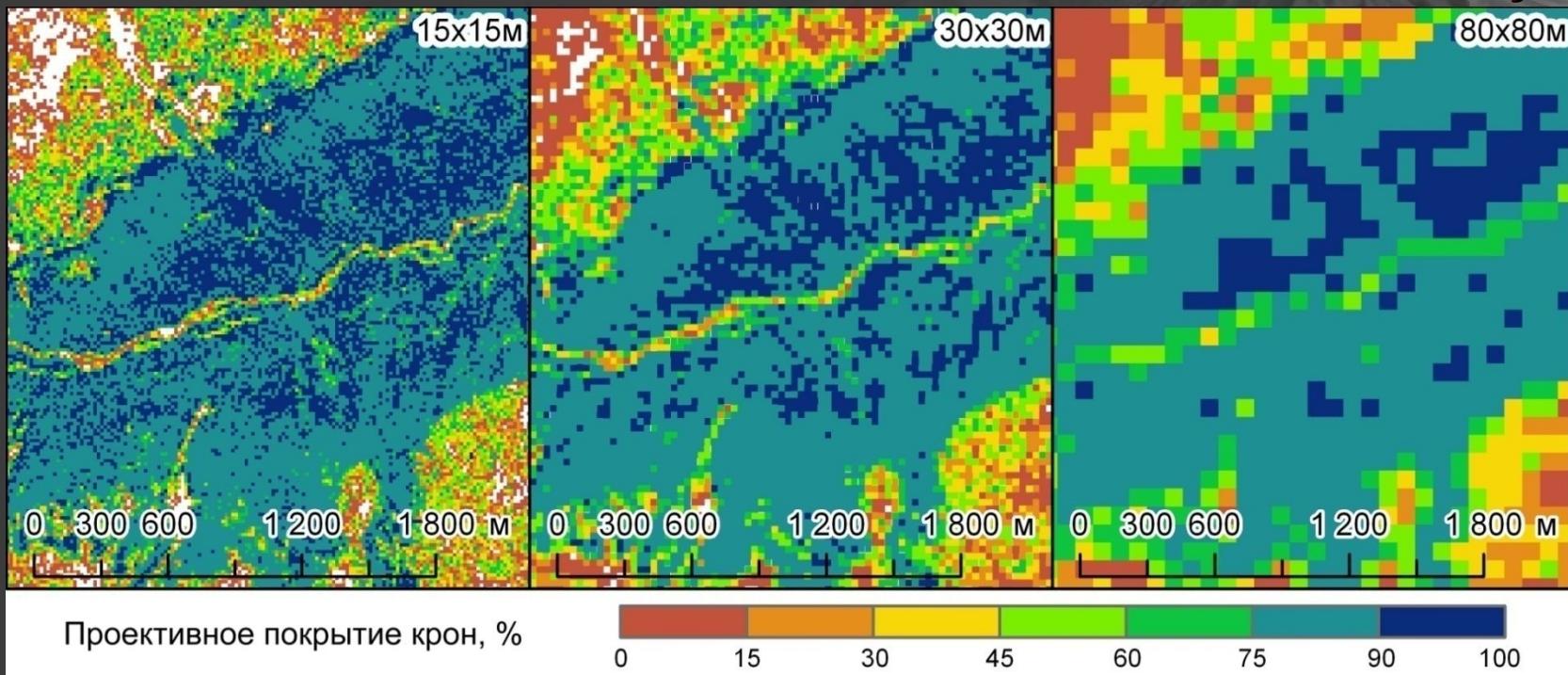
# Forest line and tree line

Putorana Plato



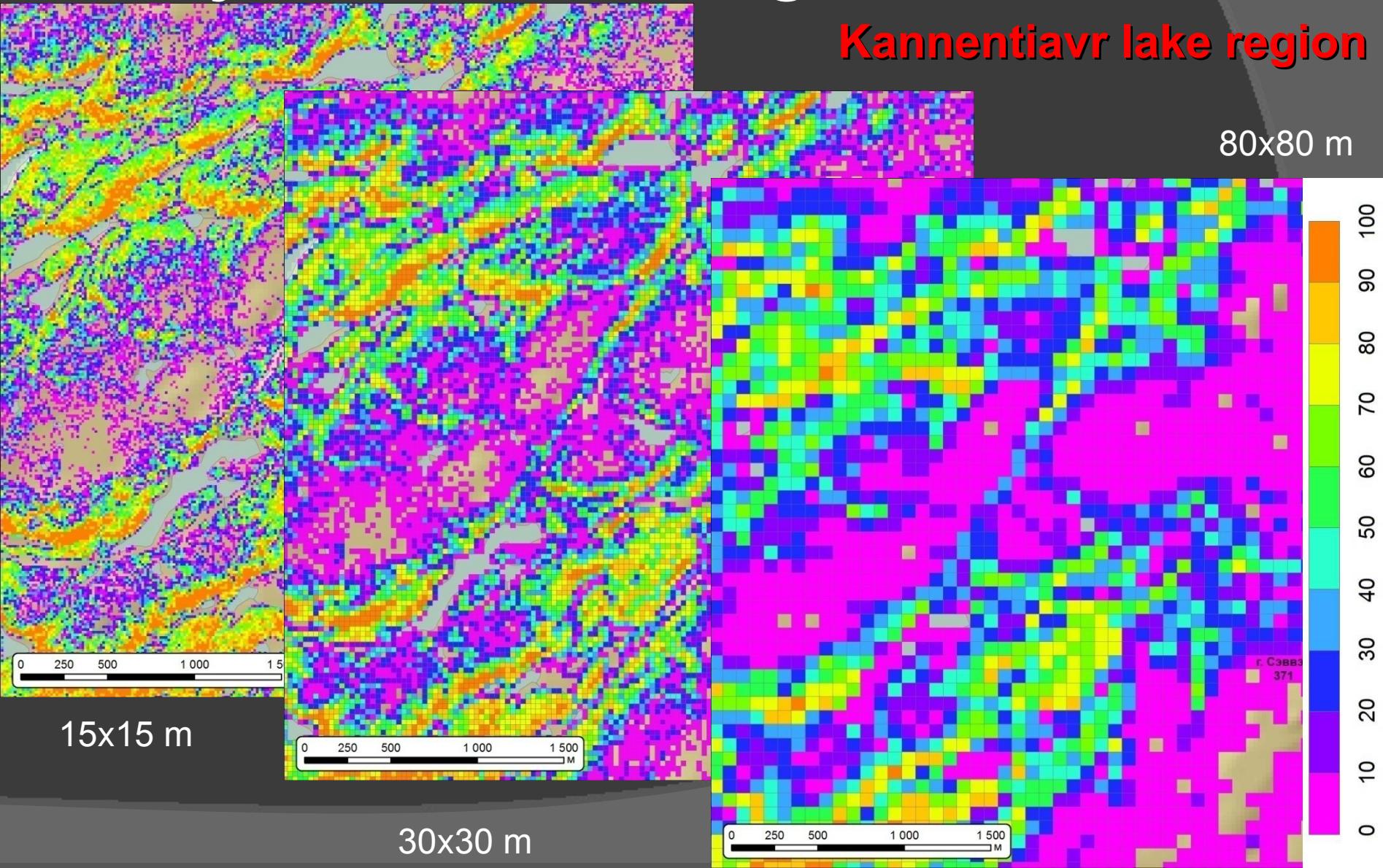
# Projective coverage

Tuliok river valley



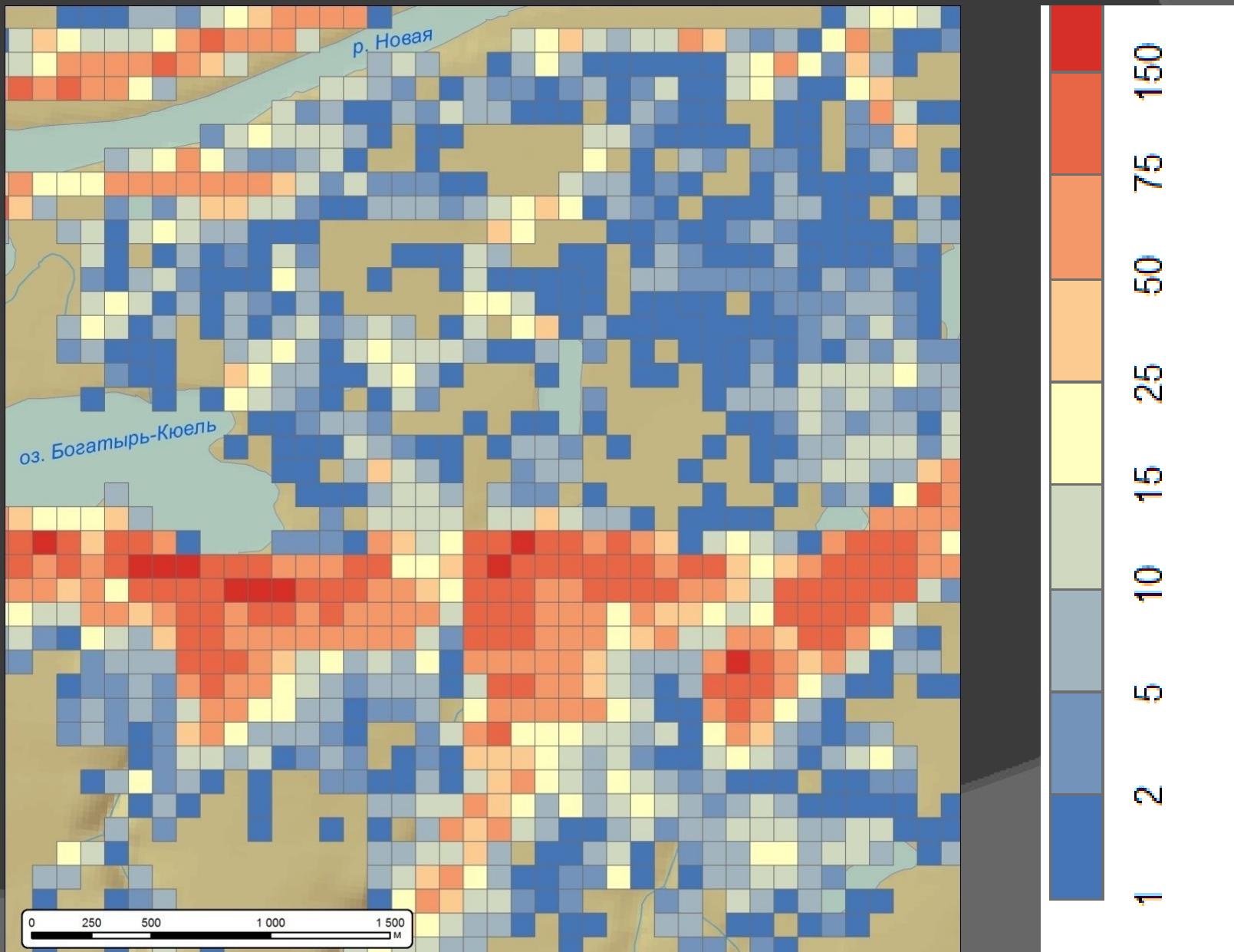
- Corresponds to spatial resolution of :  
Terra ASTER (15 m), Landsat TM (30 m), Landsat MSS (80m)
- Used for medium resolution image processing

# Projective coverage



# Stem density

Ary-Mas region



# Conclusion

- “Enhanced shadow-vegetation method” could be applied for sparse forest structure mapping in forest-tundra ecotone
- QuickBird satellite (and WorldView-2) are more recommended to be used for single trees extraction



# Questions?